

Proposed Verification Procedure
for Retrofits Used to Control Emissions
from Off-Road Large Spark Ignited Engines

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ARB recognizes the important role that verified retrofit technology will have in providing fleet owners options to meet proposed emission requirements for their in-use equipment. Verified technology ensures that the options end users choose will actually deliver real and quantifiable emission reductions.

ARB staff is proposing to adopt verification procedures for RECS that can be installed on existing off-road LSI engines. Below is a brief description of some of the most significant requirements of the proposed verification procedure.

While ARB is attempting to provide a wide range of control technologies to participate in the verification process, we are not deviating from our goal to achieve the maximum emission reductions.

Applicability: RECS would be used to control emissions of oxides of nitrogen (NO_x) and hydrocarbons (HC) from off-road LSI engines. The proposed verification procedures would apply to manufacturers of retrofit systems sold in California. These systems include but are not limited to, closed-loop fuel control systems, fuel injections systems, and three-way catalysts. These procedures are not applicable to retrofit strategies that employ or make use of fuel additives.

Application Process: To begin the verification process, an applicant must contact ARB staff to provide a preview of their plans to meet verification testing requirements. Because the verification procedure is to be used for a wide range of technologies, each with its own nature, strengths and weaknesses, working closely with ARB staff in early stages of the process is important.

Manufacturers of LSI RECS have been conducting testing and evaluation of their emissions control systems for a number of years. Their test information has been used to assist their customers in meeting OSHA requirements for equipment operating in an enclosed environment. ARB staff anticipates that some applicants may request to use this data for verification purposes. Through discussions with ARB staff a determination can be made on whether partial testing requirements have already been met and what additional testing would need to be completed to satisfy the testing requirements as specified in the proposed verification procedure.

After testing is performed, the results would be submitted to ARB staff, along with other information in an ARB approved application format. When ARB staff has reviewed the application and verified the LSI Retrofit System Verification Level (LSI Retrofit Level), an Executive Order would be issued by the Executive Officer. The Executive Order would state the verified emission reduction percentage or absolute emission level, and any conditions such as fuel, oil and any maintenance requirements specified by the manufacturer that must be met for the emission control system to perform properly.

Testing, Durability and In Field Demonstrations:

Manufacturers may use the C-2 steady state or transient test cycle when performing testing until model year 2007. Starting with the 2007 model year, the transient test cycle will be required.

Initial tests are performed to establish zero hour emission numbers (baseline and emissions reductions.) The minimum durability demonstration period is 1,000 hours if it can be correlated or demonstrated to be equivalent to 2,500 hours in-use. Otherwise, the durability demonstration period is 2,500 hours. This length of testing is needed to assure that the product is able to continue performance for the length of time stated in the warranty. There should also be a field demonstration showing that the product successfully operates in real-world conditions.

Warranty: Manufacturers are required to provide a warranty, to the purchaser, stating that the verified LSI RECS is free from defects in design, materials, workmanship or operation. The minimum period would be 3 years or 2,500 hours. Because this proposed verification procedure is for a retrofit (a piece of equipment added on to the existing equipment), an installation warranty is also required as part of the proposed procedure.

In-use Compliance: Staff proposes that manufacturers conduct an in-use compliance emission test after 50 units have been sold in California. This proposed requirement would ensure that the emission reduction performance of the verified RECS at the LSI Retrofit Level continues throughout the useful life of the retrofit.

Optional Retrofit Emission Verification Levels:

The proposed verification procedure contains several LSI Retrofit Levels that a RECS manufacturer for off-road LSI engines could choose to verify their systems. The allowed LSI Retrofit Levels are shown in Table 1, below. Depending on the LSI Retrofit Level selected, a RECS could be verified on the basis of a percentage reduction or on the basis of an absolute emission level. This approach provides flexibility for RECS manufacturers to determine the appropriate level of emission control that their technology achieves. The proposed LSI Retrofit Levels would accommodate retrofit technologies that would reduce emissions from either uncontrolled engines or certified engines. Following is a brief discussion of the various LSI Retrofit Levels allowed under the proposed verification test protocol for off-road LSI engines.

Table 1

Proposed LSI Engine Retrofit System Verification Levels

Classification	Percentage Reduction (HC+NOx) (Verified in 5% increments ⁽¹⁾)	Absolute Emission Level (HC+NOx) (Verified in 0.5 g/bhp-hr increments)
LSI Level 1 ⁽³⁾	≥ 25%	Not Applicable
LSI Level 2 ⁽³⁾	≥ 75% ⁽²⁾	3.0 g/bhp-hr
LSI Level 3a ⁽³⁾	≥ 85%	0.5, 1.0, 1.5, 2.0, 2.5 g/bhp-hr
LSI Level 3b ⁽⁴⁾	Not Applicable	0.5, 1.0, 1.5, 2.0 g/bhp-hr

- Notes
- ⁽¹⁾ Increments applicable to LSI Level 2 and LSI Level 3a classifications only
 - ⁽²⁾ The allowed verified percentage reduction for LSI Level 2 is capped at 75% regardless of actual emission test values
 - ⁽³⁾ Applicable to uncontrolled engines only
 - ⁽⁴⁾ Applicable to emission-controlled engines only

LSI Level 1 is the lowest level that would be allowed for verification under the proposed protocol. This LSI Level applies to uncontrolled LSI engines and would require a minimum reduction of 25 percent of HC+NOx from baseline uncontrolled emission level.

LSI Level 2 is the next level of verification for uncontrolled engines and requires the RECS to achieve either a minimum 75 percent reduction of HC+NOx from baseline level, or an emission level of 3.0 g/bhp-hr of HC+NOx. Staff anticipates that the majority of retrofit technology would be able to achieve this level of emission reductions for LSI engines operating on liquefied petroleum gas (LPG).

The highest level of verification allowed under the proposed protocol for uncontrolled engines is LSI Level 3a. Under this level, the retrofit system must demonstrate at least an 85 percent emission reduction of HC+NOx from baseline uncontrolled emission level. Alternatively, a retrofit system could be verified to LSI Level 3a at an absolute emission level ranging from 0.5 g/bhp-hr to 2.5 g/bhp-hr, in 0.5 g/bhp-hr increments, as shown in Table 1, above.

The final step of verification allowed is LSI Level 3b. This level has been designed to allow for verification of retrofit systems that will further reduce emissions from engines already certified to existing emission standards. LSI Level 3b would allow the retrofit system to be verified to reduce emissions from emission-regulated engines to an absolute emission level ranging from 0.5 g/bhp-hr to 2.0 g/bhp-hr, in 0.5 g/bhp-hr increments.